HCAL Commissioning in Proton Collisions at 7 TeV

CMS PAS JME-10-007

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For HCAL DPG

Content

- HCAL description
- Calibration
- Time reconstruction
- HCAL input for L1 triggers
- DQM and data certification
- Anomalous signals and their filtering
- HF PMT hits simulation

Calibration

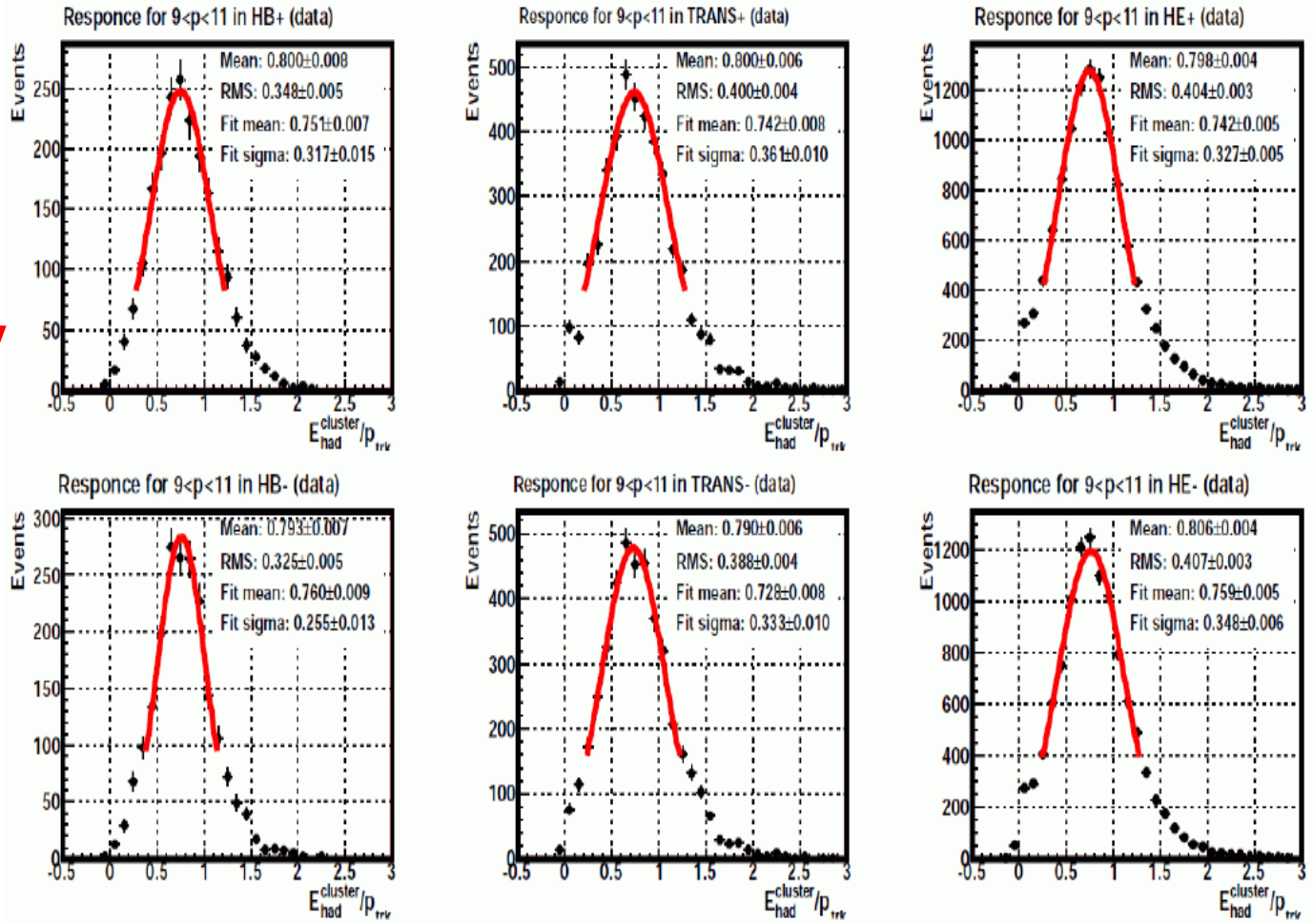
- Pre-calibration (~10% for HB/HE/HF)
  - Test beam
  - Co-60 source
  - Cosmic muons
  - Splash data
- Collision data (need about $10pb^{-1}$)
  - Phi symmetry for NZS data
  - Isolated hadron response (at $|\eta| < 2.2$)

Isolated hadron response

Plots will be updated

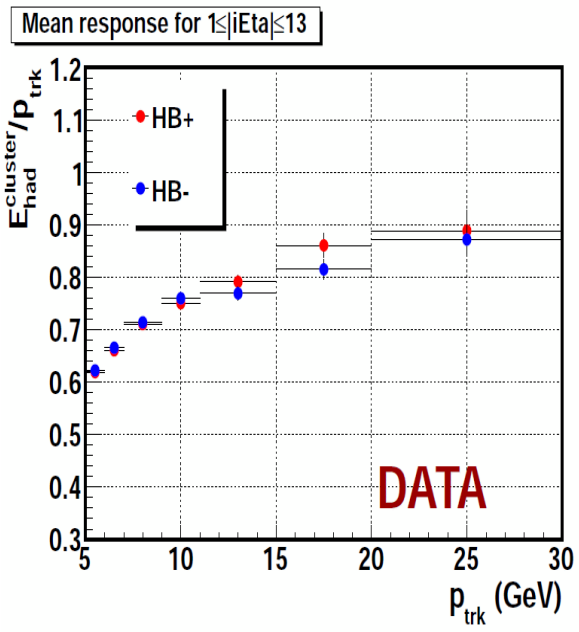
9 < Ptrk < 11 GeV

MIP in ECAL

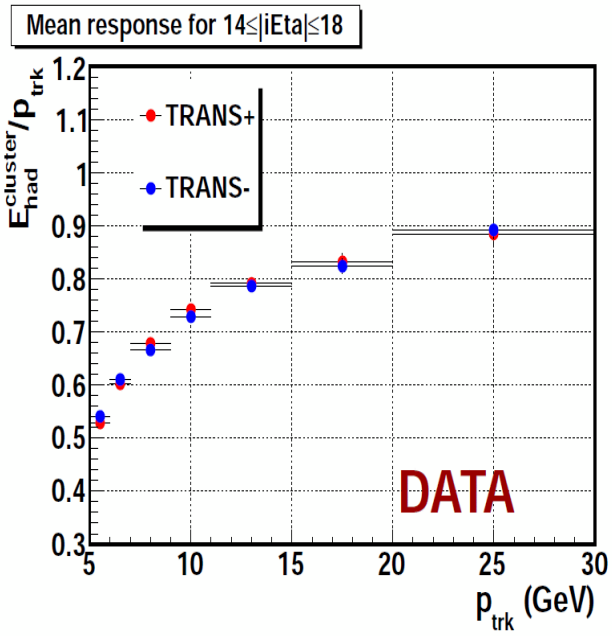


Response vs track momentum

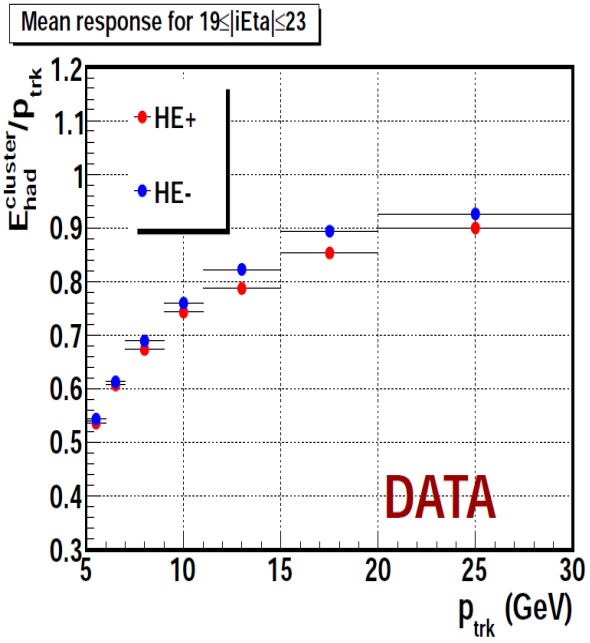
Barrel



HB/HE Transition

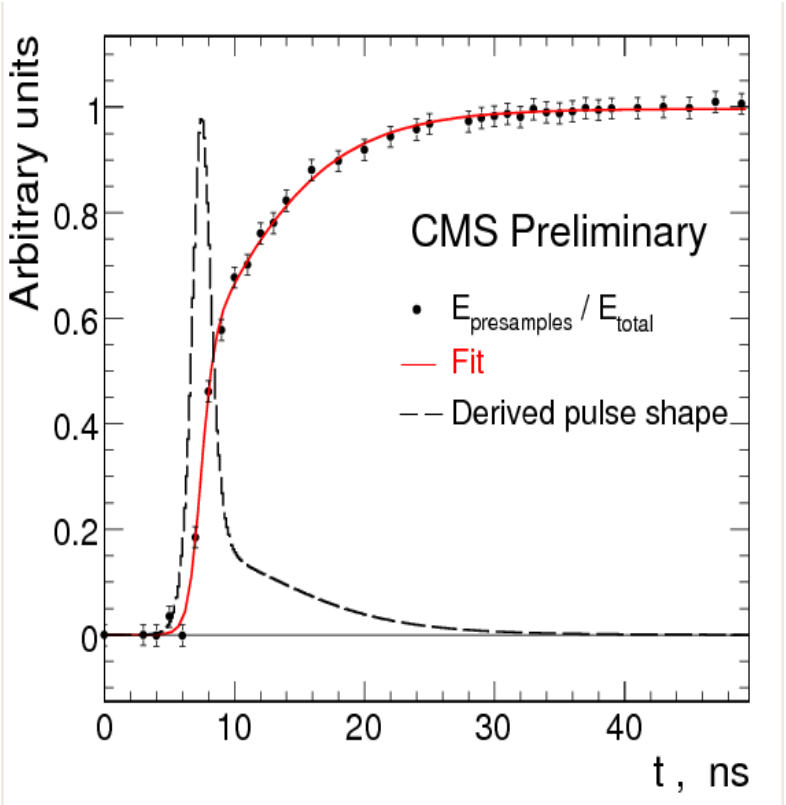


Endcap

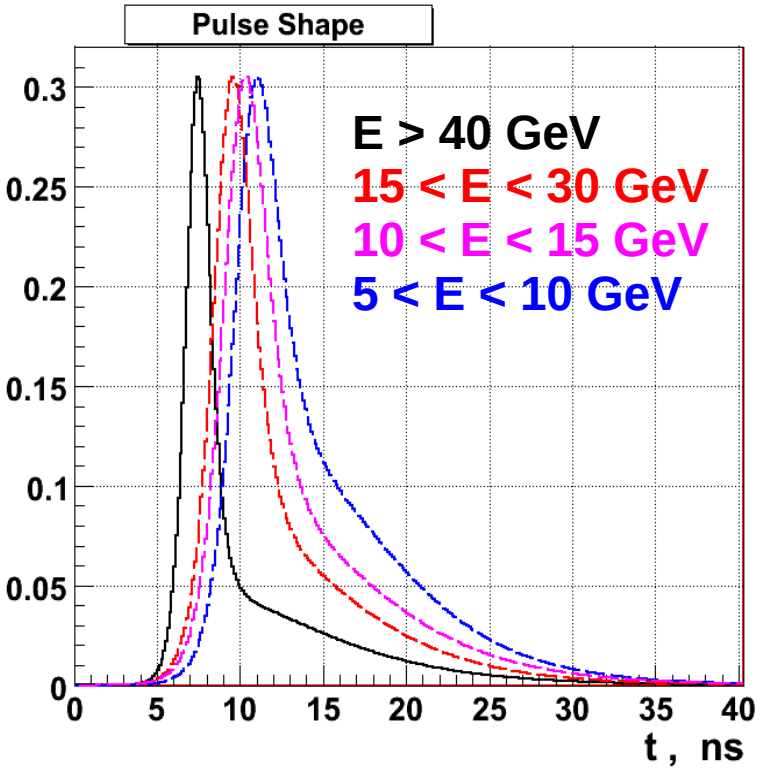


HF pulse shape from time scan

E > 40GeV

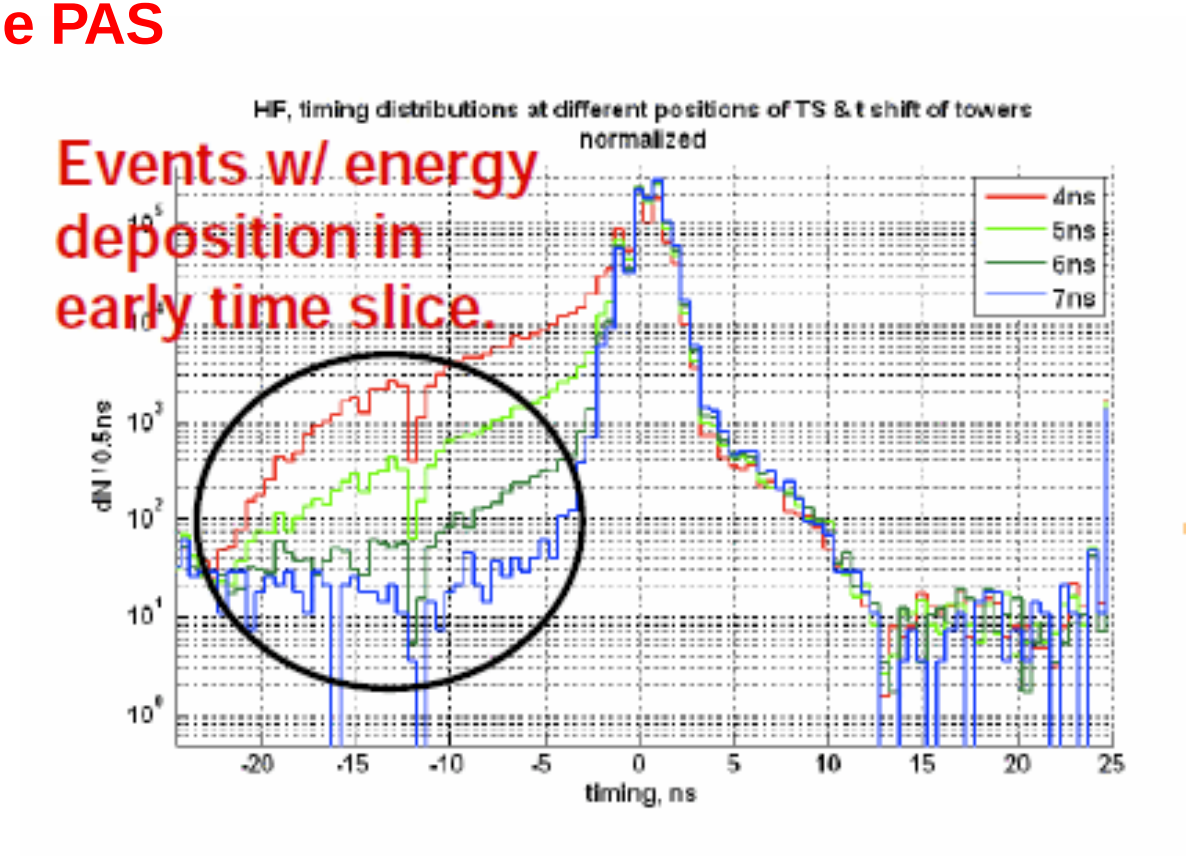


Different energies



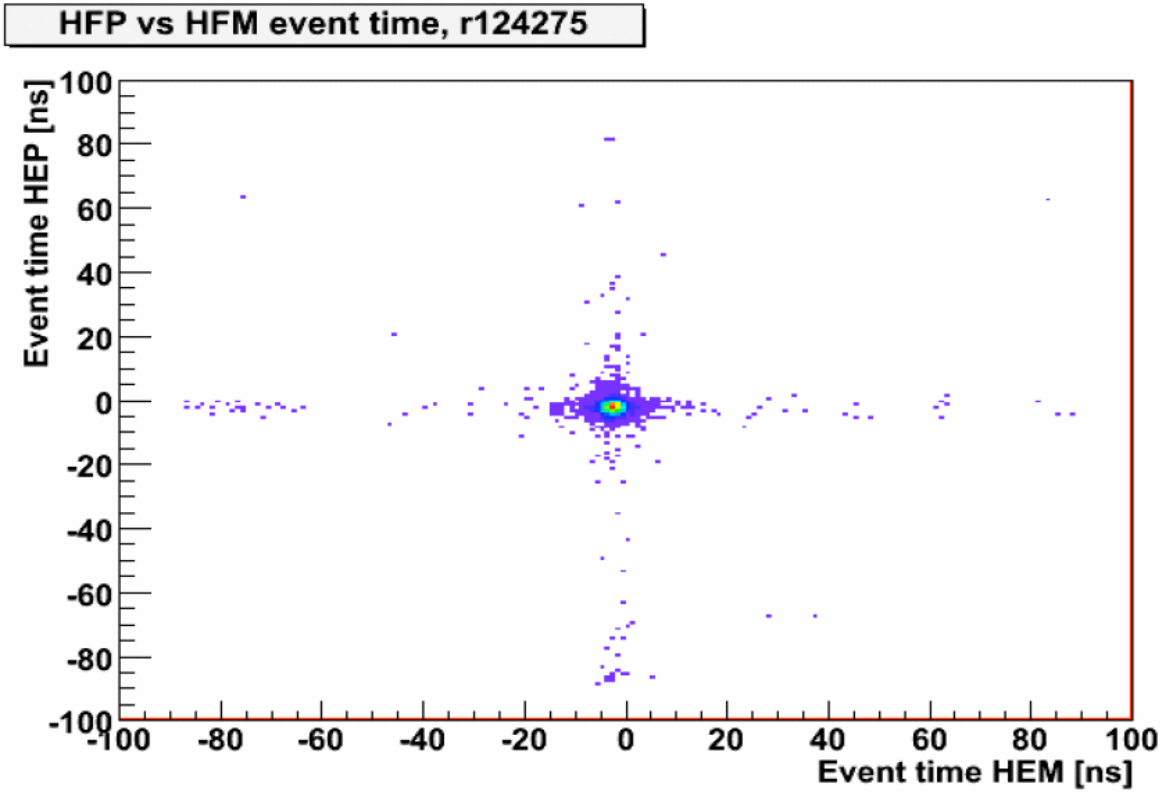
Choice of HF phase

Not in the PAS



Optimal phase: 7 ns

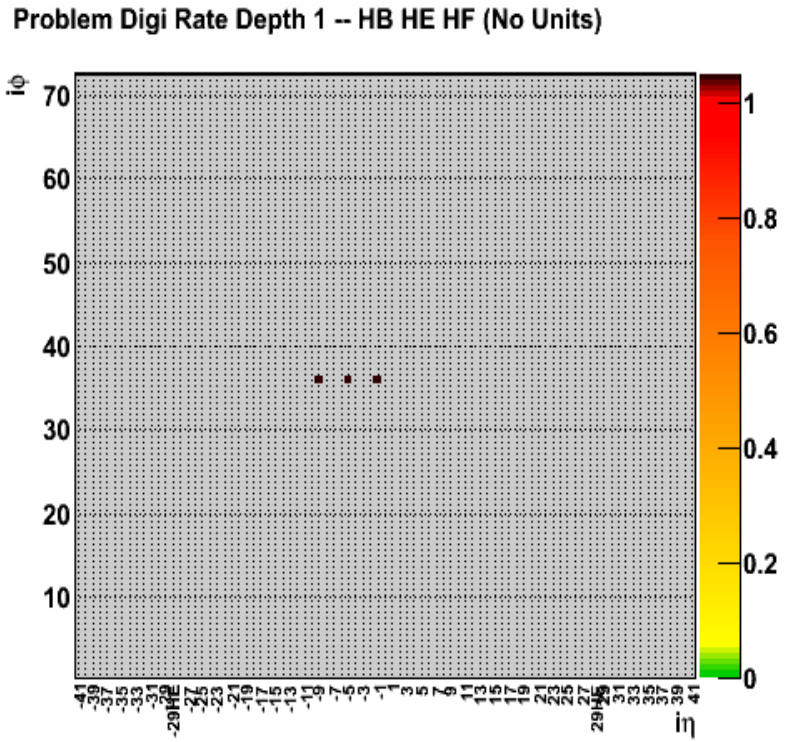
HF time for good collision selection



HFP/HFM time is energy weighted time for channels

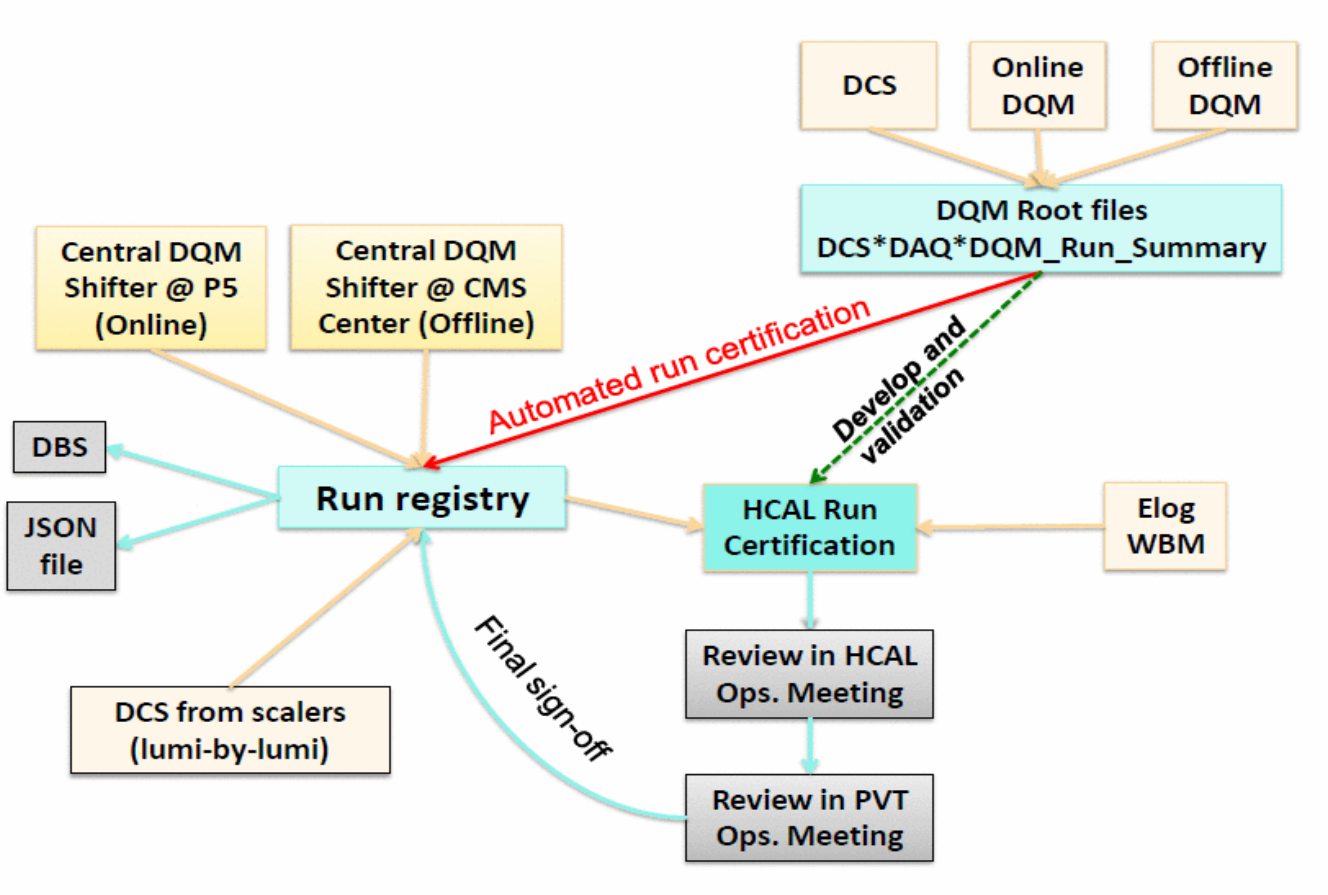
DQM

- **Raw Data Test – check format**
- **Digi Test – check digi integrity**
- **Dead Sell Test**
- **Trigger Primitive Test**
- **HF Lumi Test**
- **Pedestal Test**
- **Laser test**



Digi Monitor output for run 137022
3 HB channels have a broken fiber

HCAL data certification

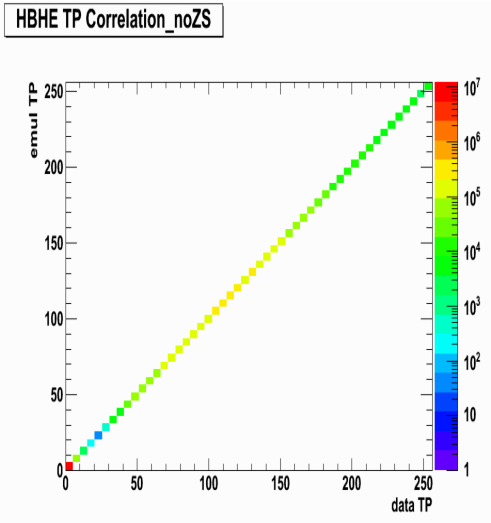


HCAL TPs: Emulation vs Data

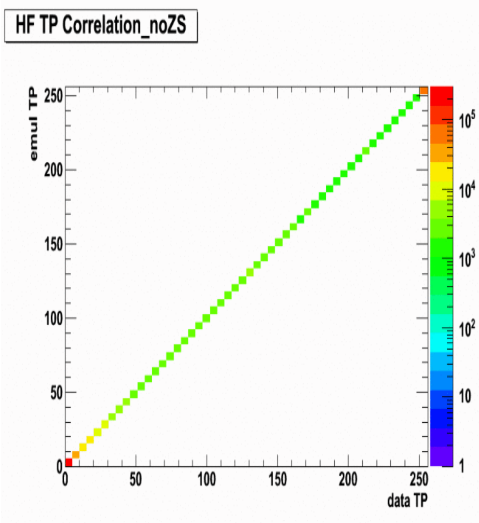
Values of HCAL TPs are compared with their emulation from HCAL digi

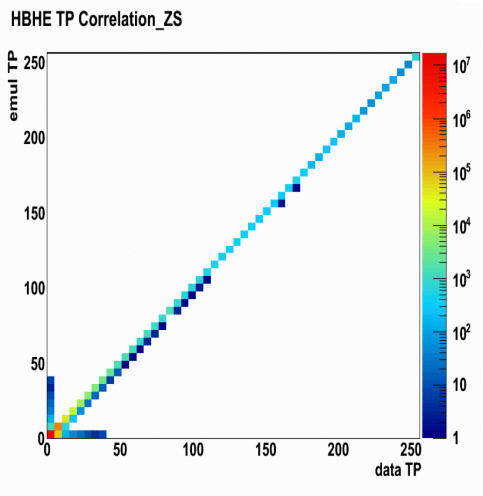
For NZS case the results are exactly the same for both cases

For ZS case the result are different

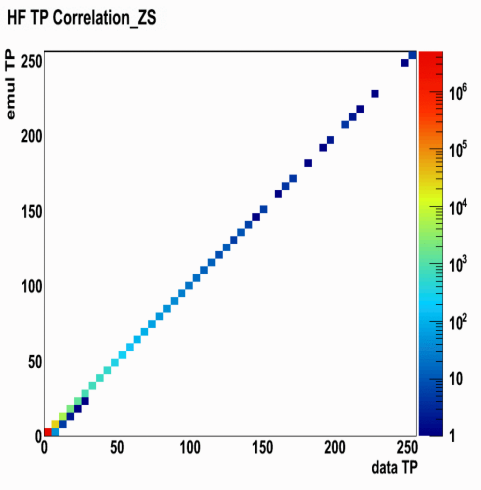


NZS





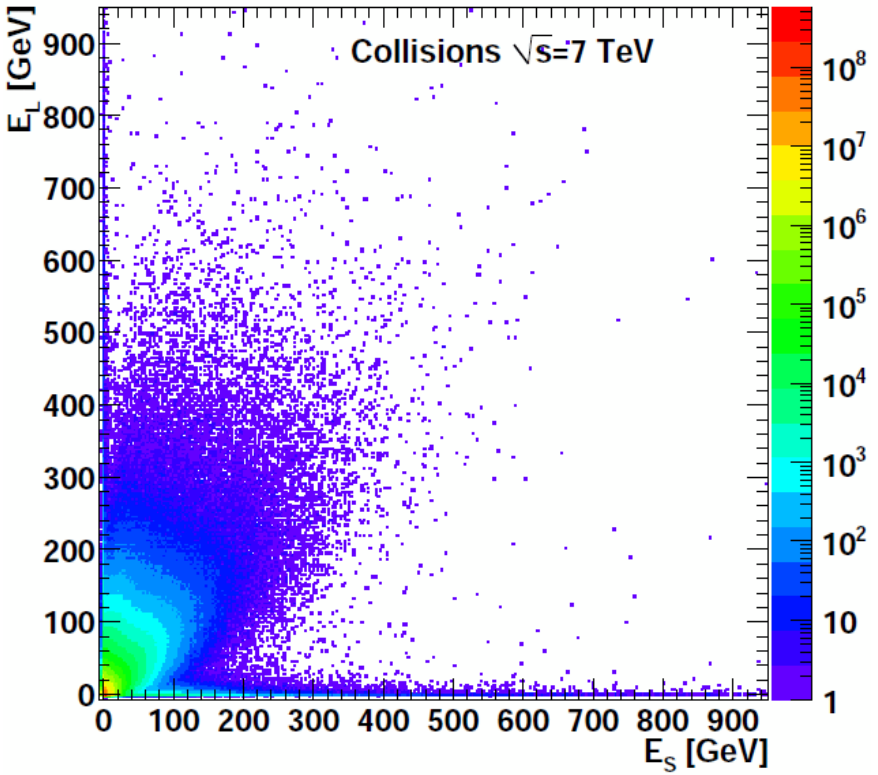
ZS

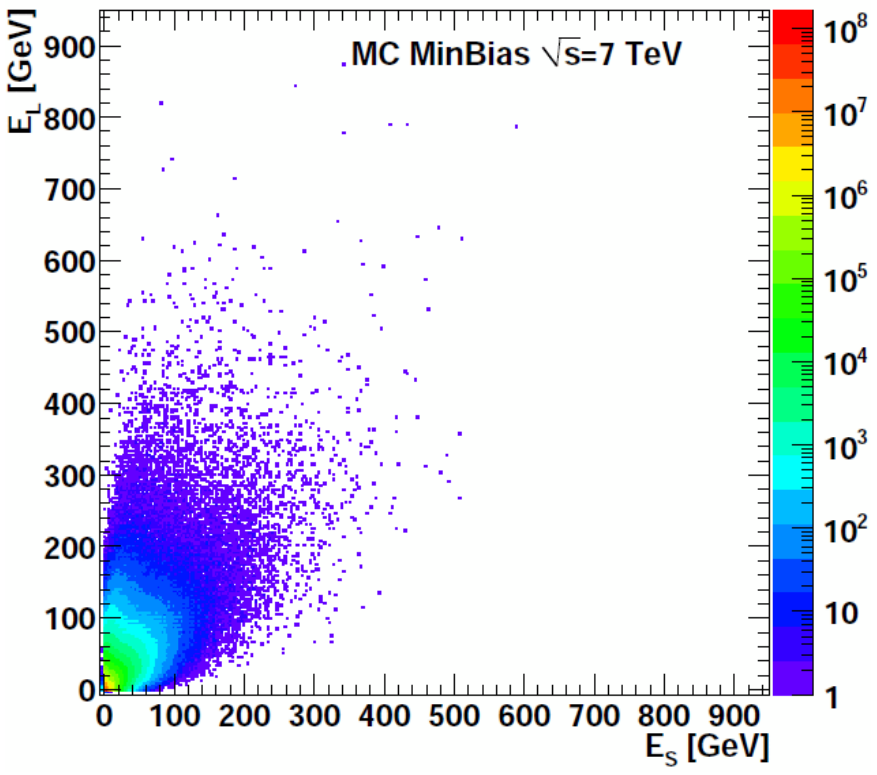


HB/HE

HF

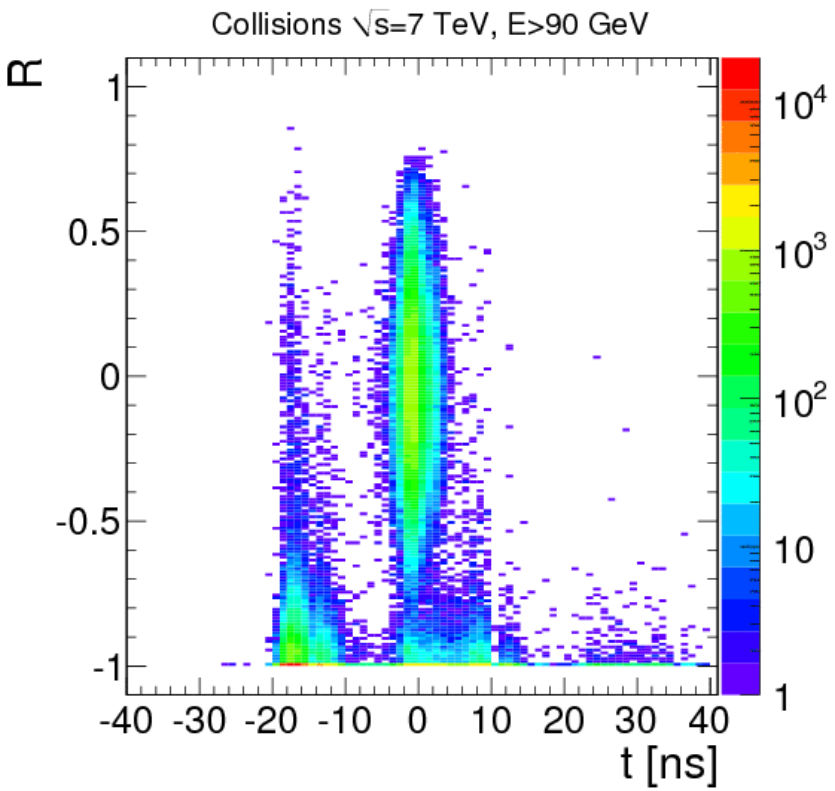
HF PMT hits: L vs S

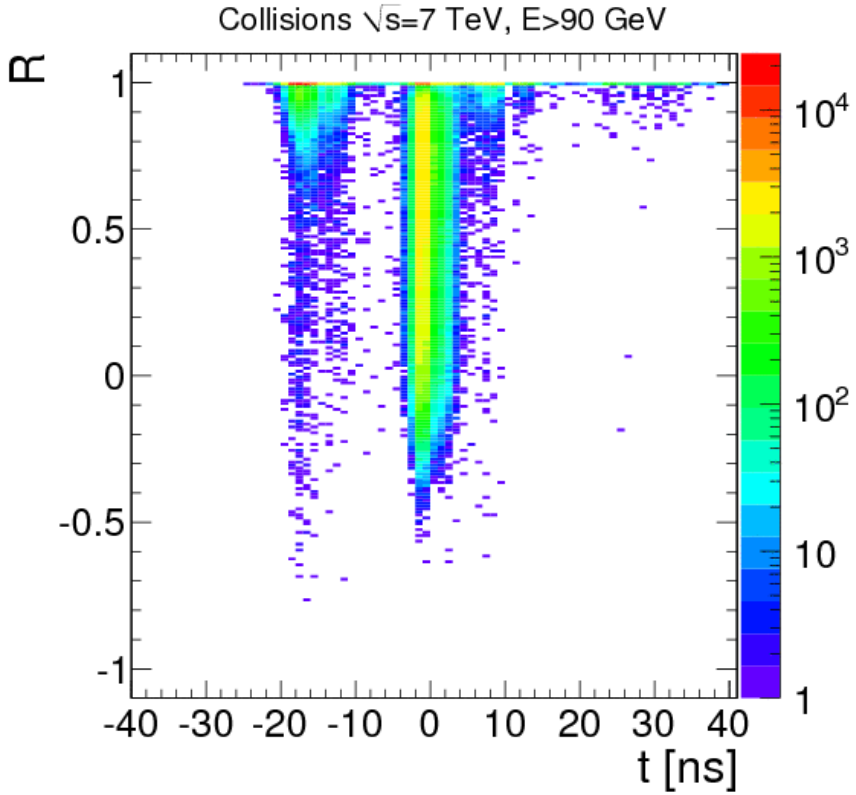




R vs Time

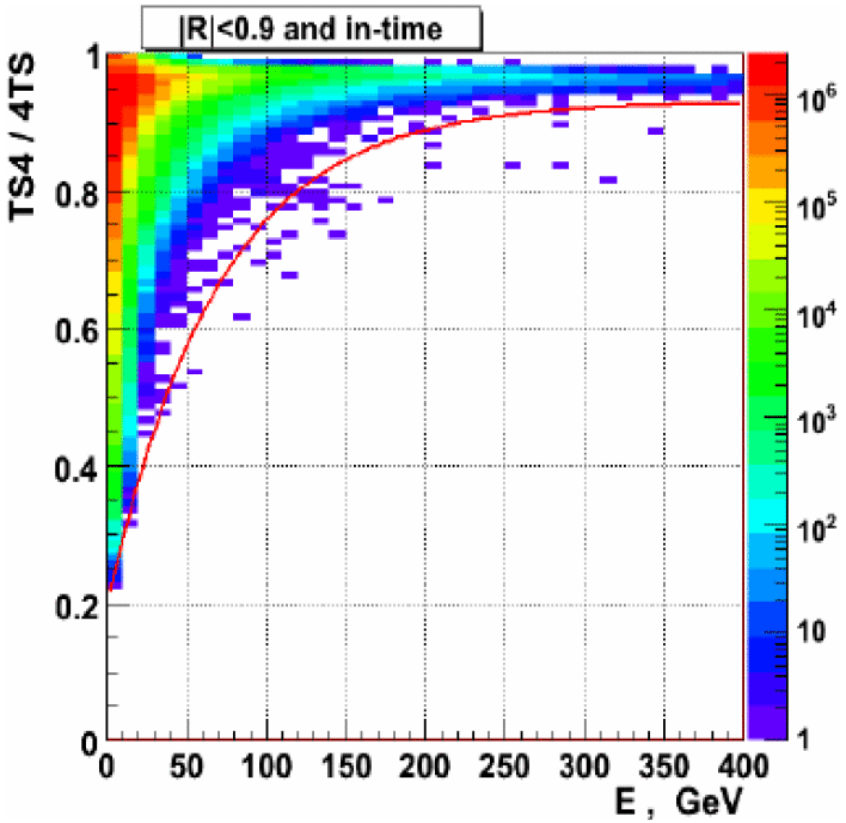
R = (L – S)/(L + S), E > 90 GeV

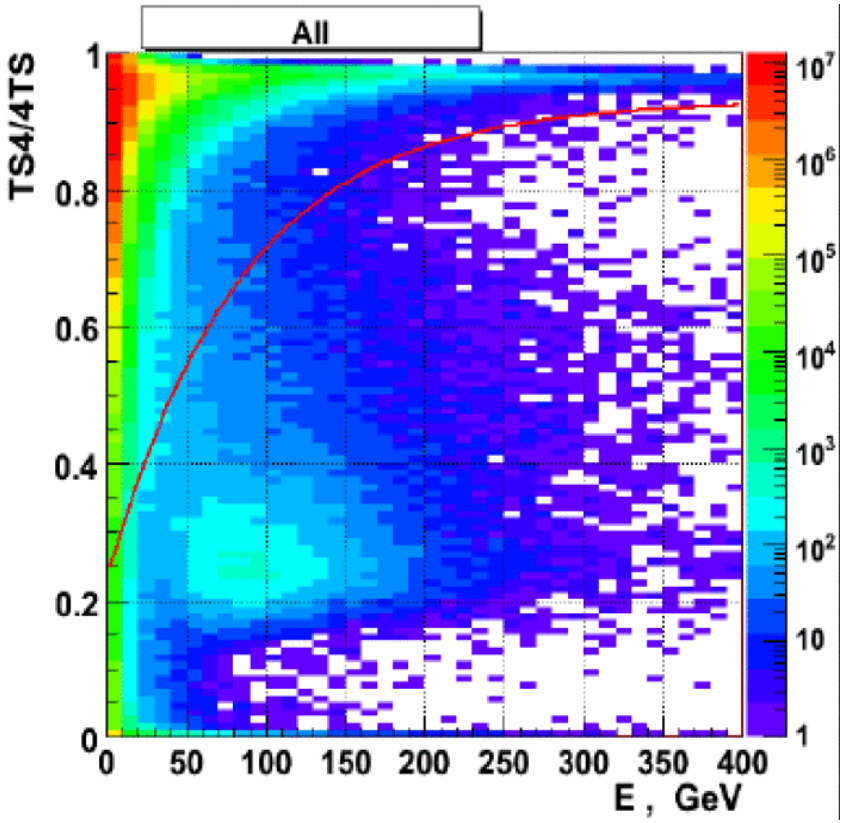




Pulse shape for HF cleaning

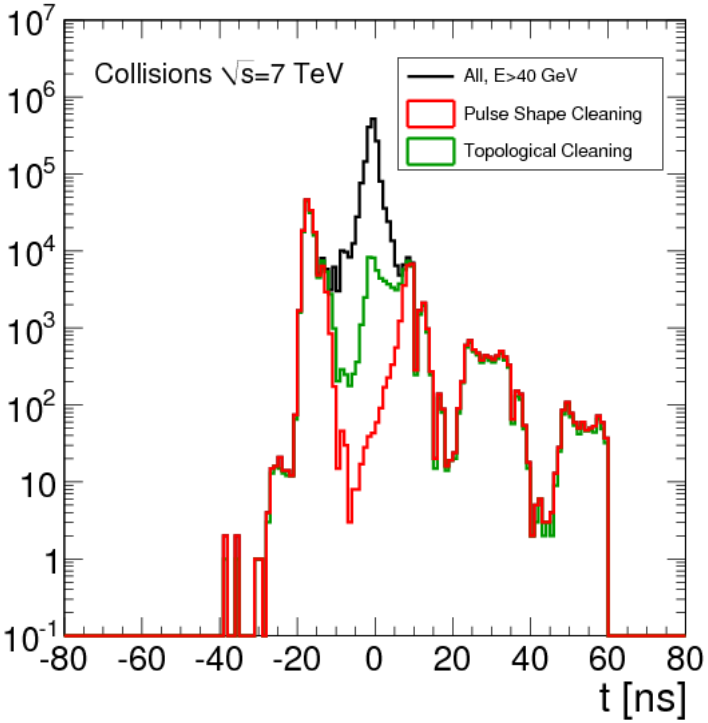
TS4/(TS3+TS4+TS5+TS6)



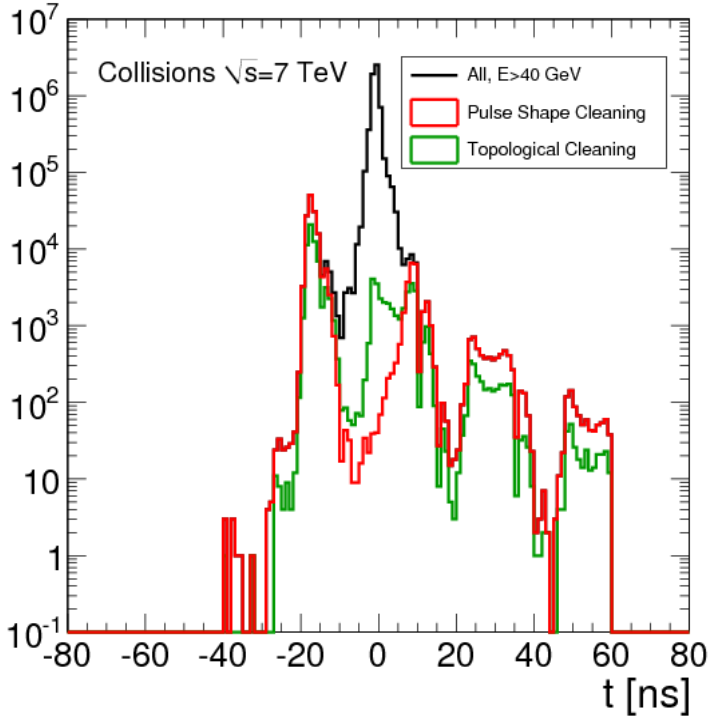


HF PMT hit filters

S fiber cells

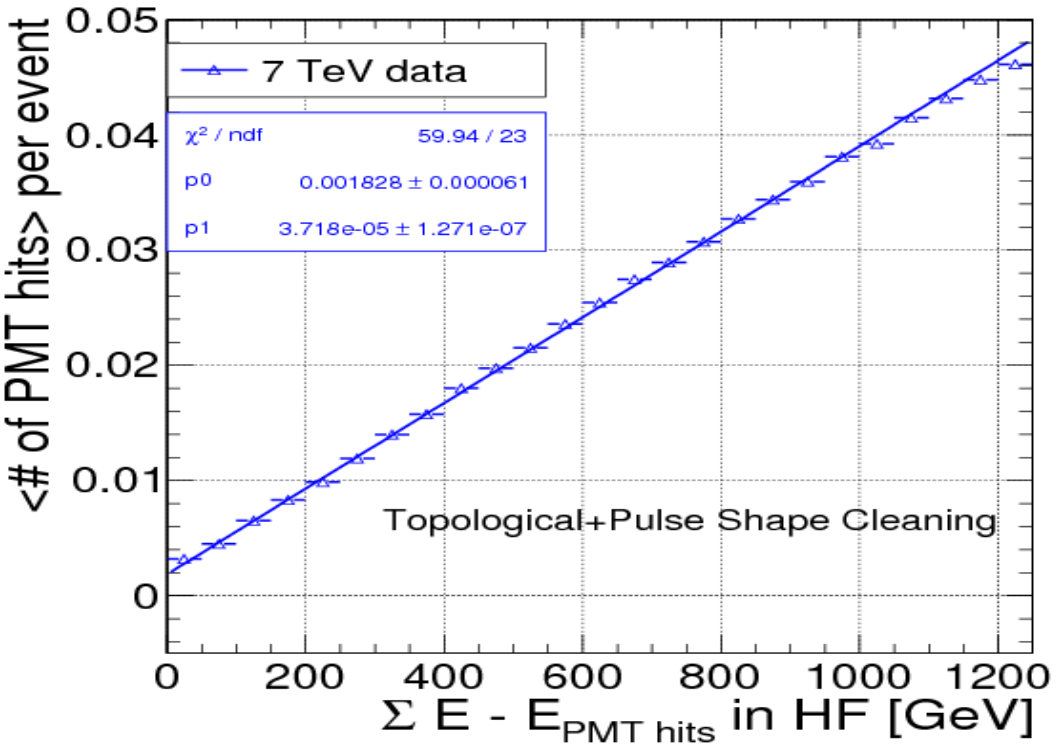


L fiber cells



HF PMT hit rate and multiplicity

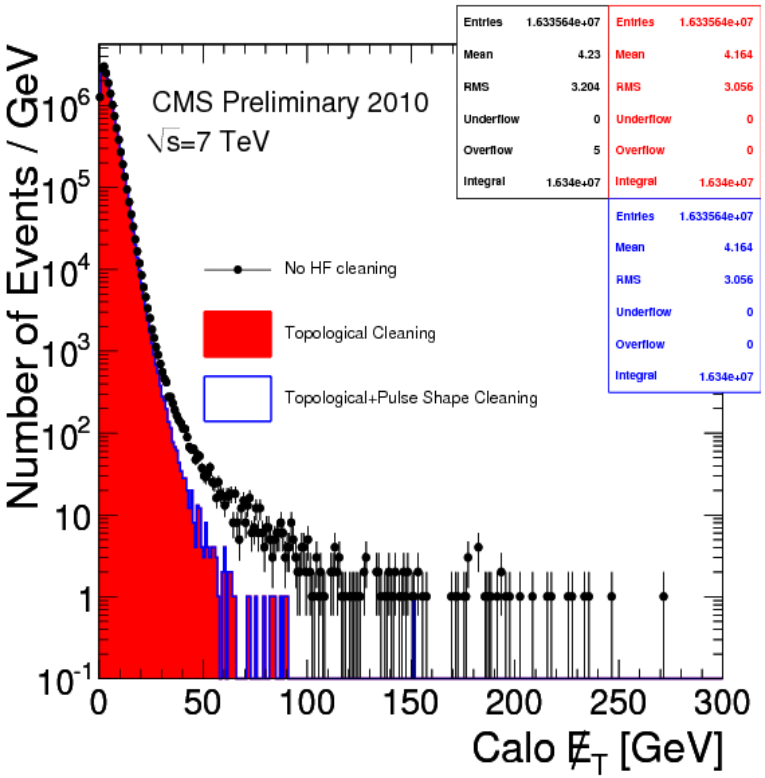
Plot will be updated



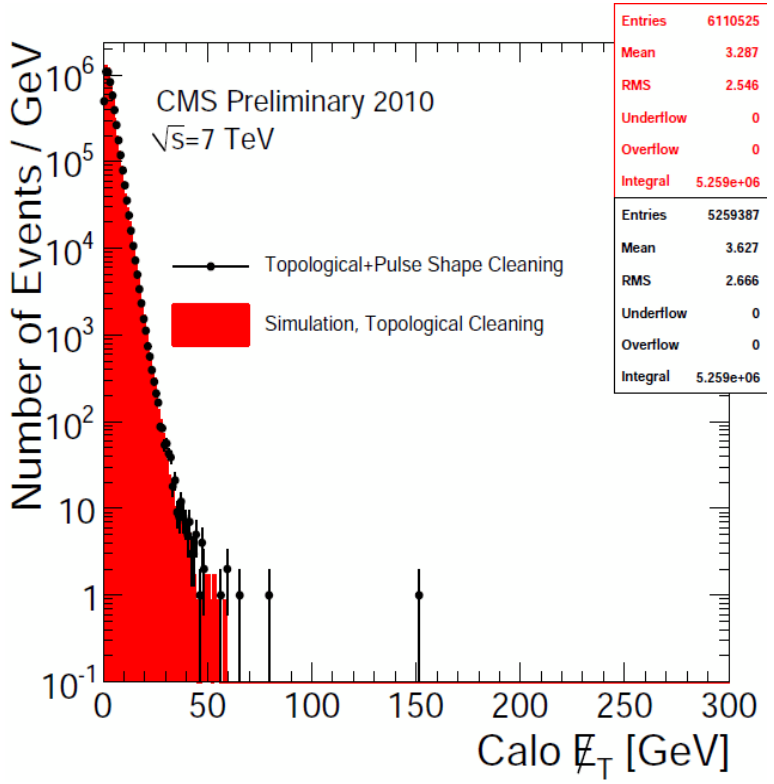
HF filter performance for MET

Plots will be updated

All events



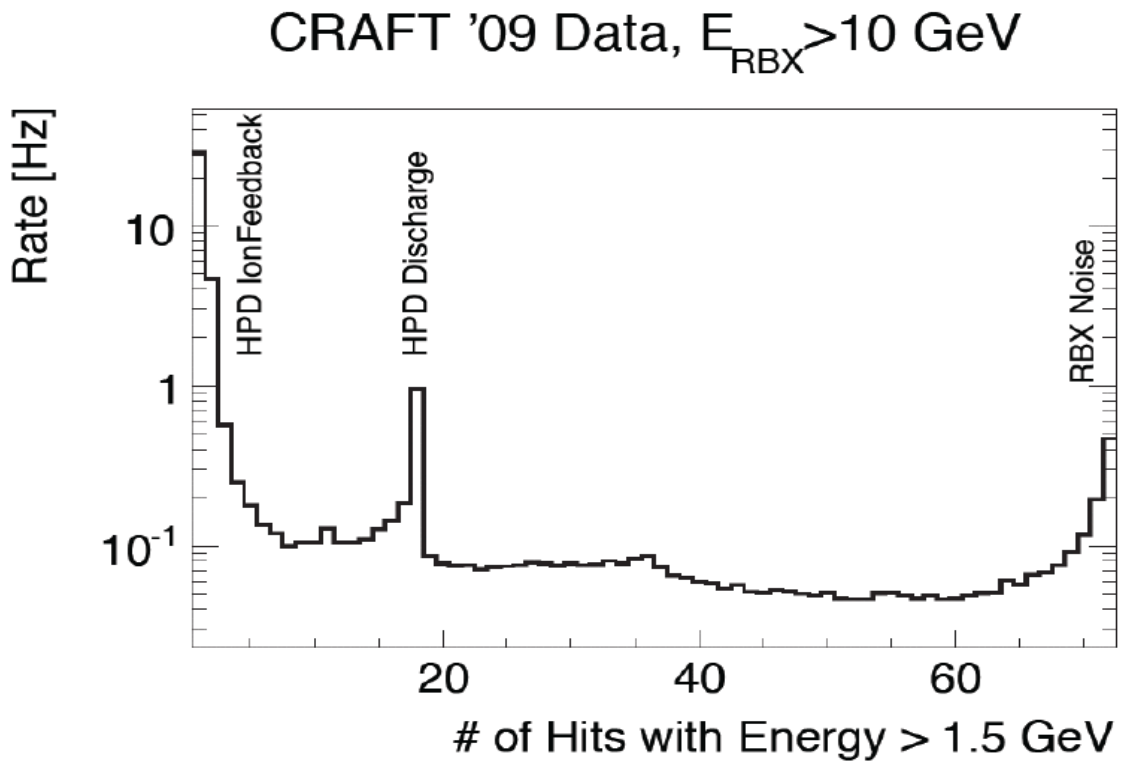
MinBias events



HB/HE noise classification

HPD: 18 channels

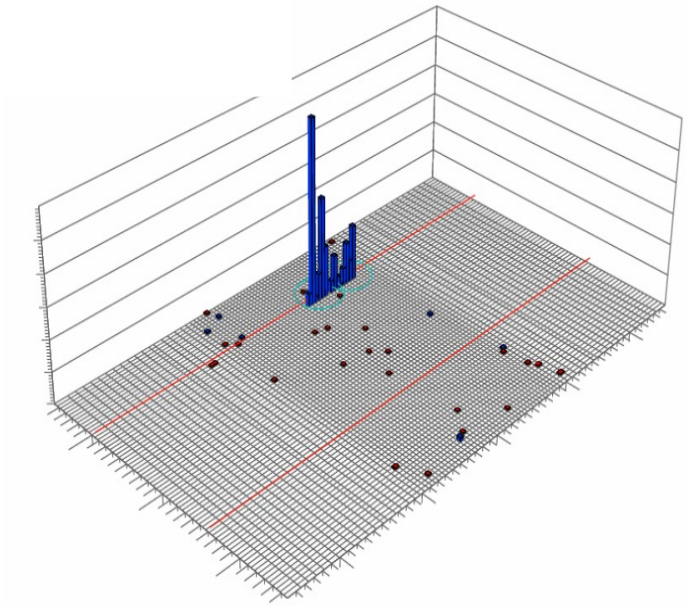
RBX: 4 HPD



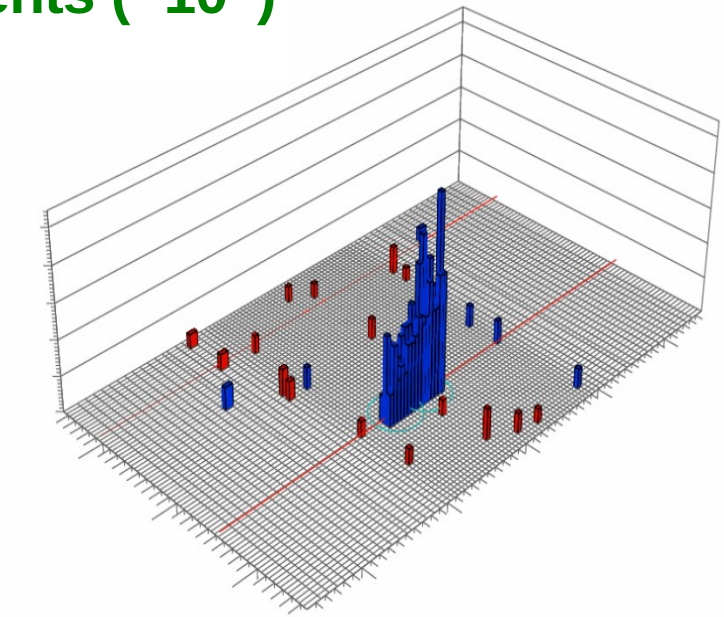
HPD & RBX noise events

Random noises

Rare overlap with physics events (~10^{-5})



HPD noise

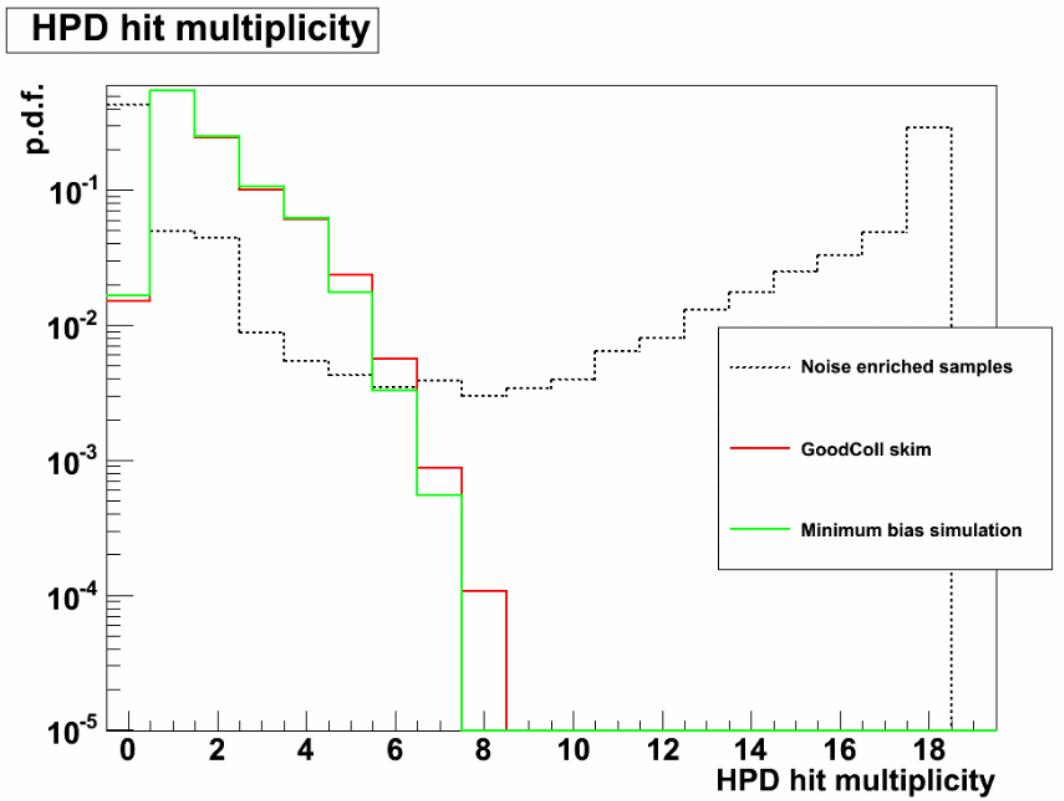


RBX noise

HPD hit multiplicity

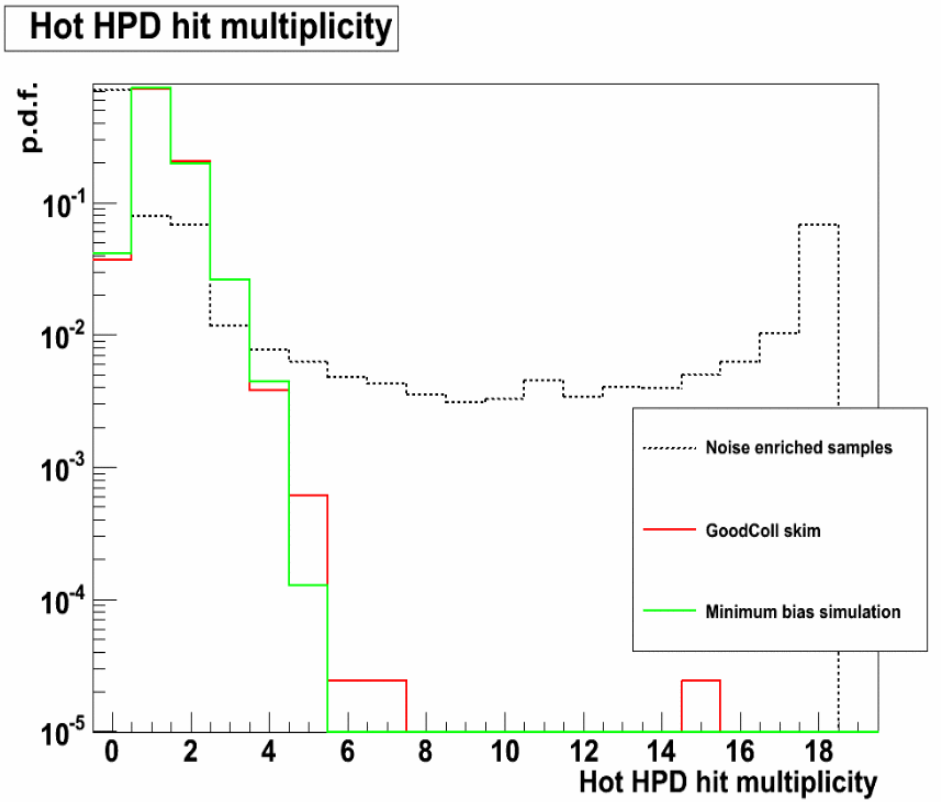
E > 1.5 GeV

N < 17



“Hot” HPD hit multiplicity

N < 10



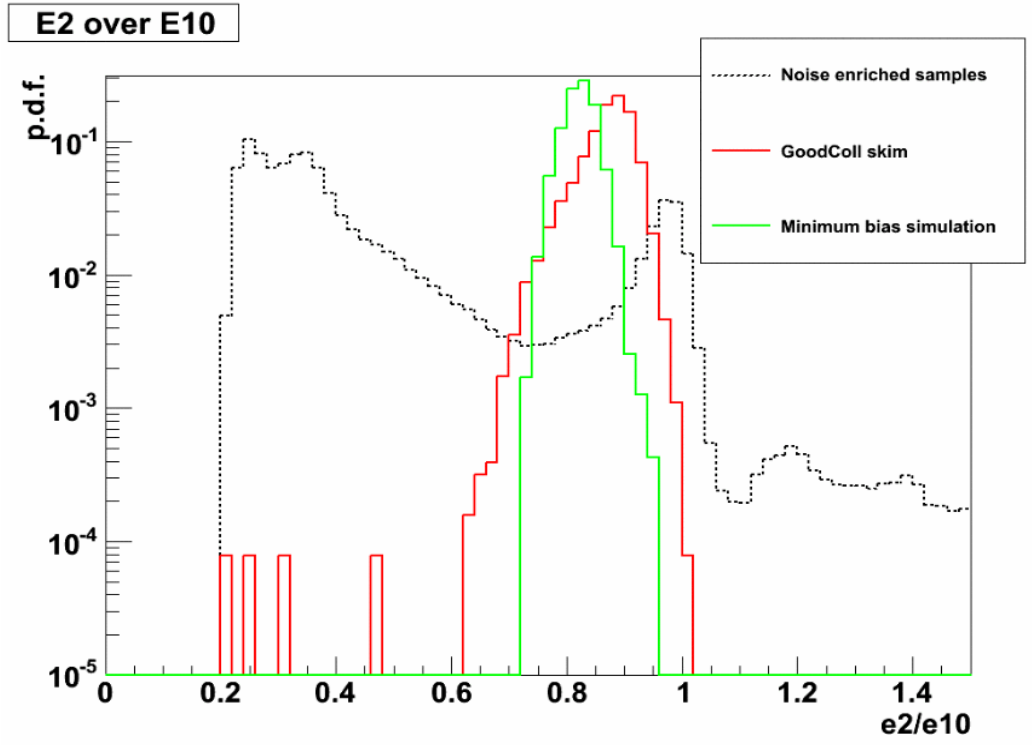
“Hot” HPD means no other HPDs from the same RBX produced signals in the event

Digi shape

Ratio E2/E10 construted for all channels in the same RBX with E>1.5 GeV

E_{RBX} > 50GeV

0.65 < E2/E10 < 0.98

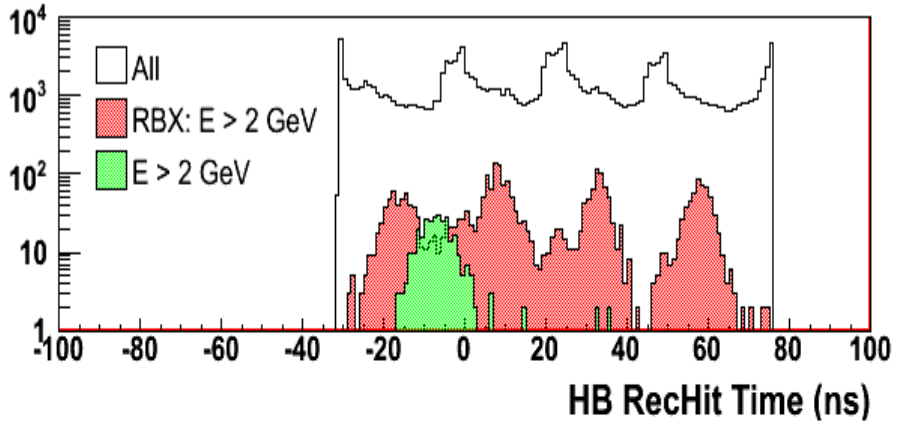


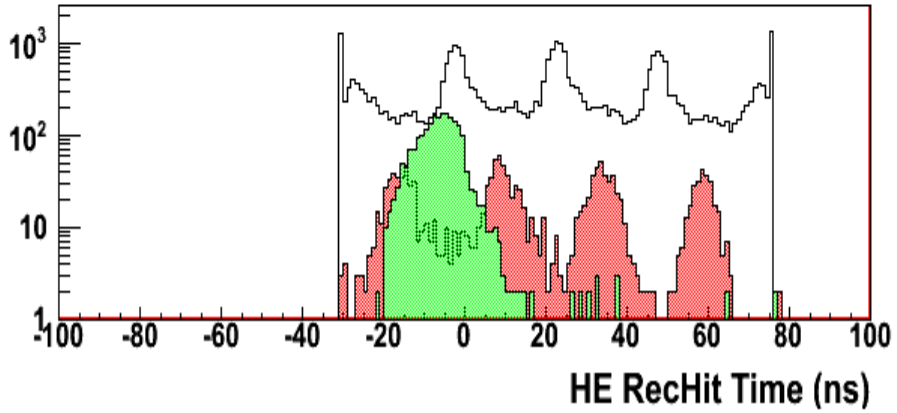
HB HE rechit time

Noise sample

MET > 45 GeV

E > 2 GeV





HPD/RBX noise filter at HLT

- Filter as it exists on the Jet15U path
  - Reject an event if an RBX with E>50 GeV has:
    - pulse shape ratio, E(2TS)/E(10TS) falls outside of [0.65,0.98], OR...
    - ≥10 ADC 0 counts found in the RBX, OR...
    - ≥17 hits (E>1.5 GeV) found in a single HPD OR...
    - ≥10 hits (E>1.5 GeV) found in a single HPD and no other hits in RBX

      AND

    - RBX EMF<2%

      AND

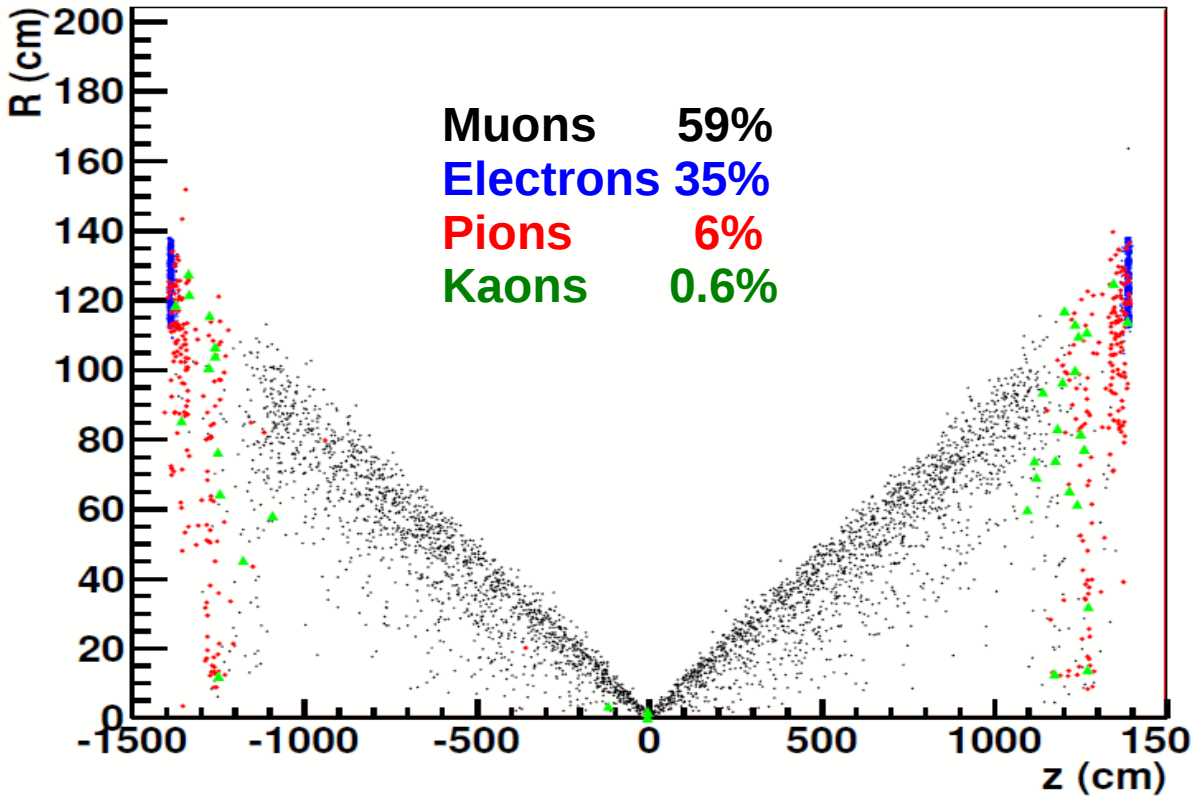
    - At most 2 RBXs with E>10 GeV in the event
- *Very* safe for physics, and rejects large fraction of high energy noise
  - Out of 5000 ttbar events, none were ID'd as noise

8E29 Menu ($\sqrt{s}$=10 TeV)

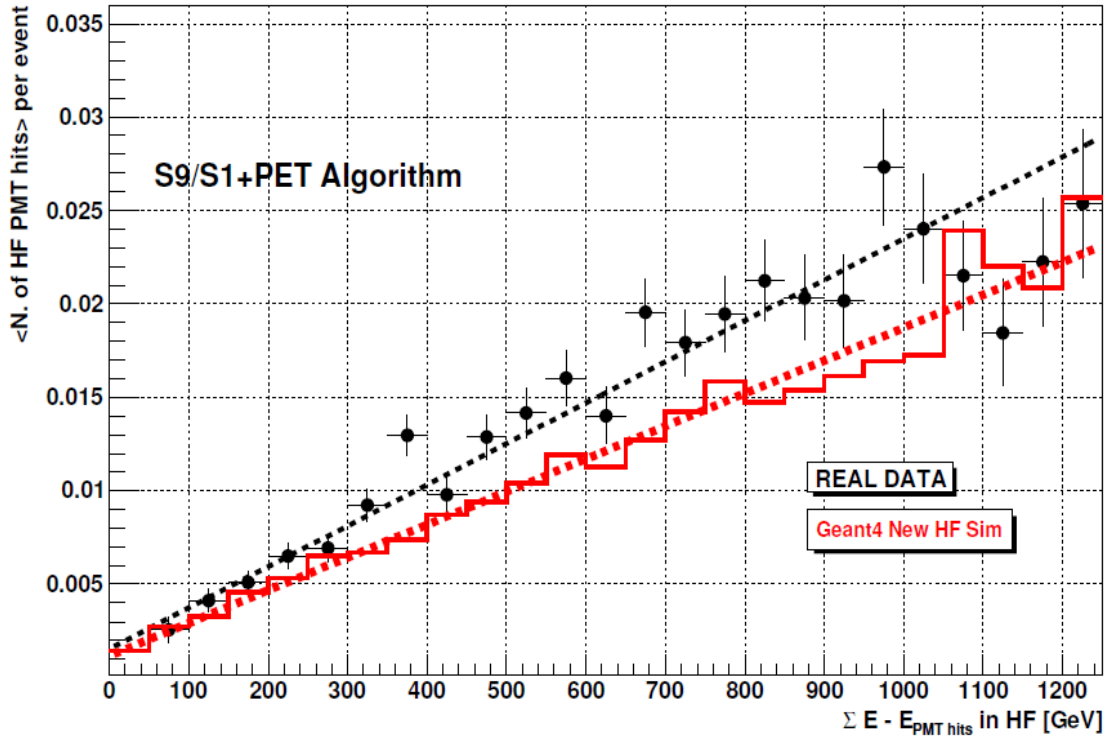
Trigger	Total Prescale	Noise Rate (Hz)	Physics Rate (Hz)	**Noise Rate after Filter (Hz)**
Jet 6	×500	~ 0.15	6.21 ± 0.19	---
Jet 15	×25	~ 0.51	8.11 ± 0.22	**~0.3**
Jet 30	×1	~ 7.7	17.71 ± 0.33	**~2.5**
Jet 50	×1	~ 5.0	3.01 ± 0.13	**~0.9**
MET 20	×2	~ 5.0	7.04 ± 0.21	---
MET 45	×1	~ 6.4	~ 0.2	**~1.2**
MET 100	×1	~ 2.2	~ 0.0	**~0.4**

HF PMT hit simulation (1)

Origins of particles hitting HF PMTs



HF PMT hit simulation (2)



Supporting material

Plans and Methods for HCAL Calibration with Early Collision Data
https://twiki.cern.ch/twiki/pub/CMS/HcalCalibrationGroup/calibration.pdf

Anomalous HB/HE Noise at Startup: Characteristics and Rejection Algorithms
http://cms.cern.ch/iCMS/jsp/openfile.jsp?type=IN&year=2010&files=IN2010_006.pdf

HCAL Noise Working Group Summary for CMS Summer 2010 analyses
http://cms.cern.ch:80/iCMS/jsp/openfile.jsp?tp=draft&files=AN2010_165_v1.pdf

Optimization and Performance of HF PMT Hit Cleaning Algorithms Developed Using pp Collision Data at 0.9, 2.36 and 7 TeV
http://cms.cern.ch/iCMS/jsp/openfile.jsp?tp=draft&files=DN2010_008_v1.pdf